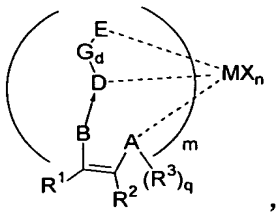
Claims

1、A catalyst or catalytic system for olefin polymerization and copolymerization, the catalyst has the following formula:



,

wherein:

→: is single bond or double bond;

·····: is coordination bond or covalent bond;

—: is covalent bond or ionic bond;

Which, E binds M by coordination bond, A binds M by covalent bond and D binds M by coordination bond or by covalent bond;

m: 1, 2 or 3;

q: 0 or 1;

d: 0 or 1;

M: transition metal from group 3 to group 11, examples of M are Ti, Zr, Ni, Pd, Fe, Co;

n: 1, 2, 3 or 4;

X is hydrogen, halogen, hydrocarbyl substituted hydrocarbyl group containing oxygen atom, group containing nitrogen atom, group containing sulfur atom, group containing boron atom, group containing aluminum atom, group containing phosphor atom, group containing silicon, group containing germanium atom or group containing selenium atom, each X in the formula could be the same or not, two or more canbe linked to form one or more cyclic substitutes;

The absolute value of total negative charges of all ligands in the formula is as same as the absolute value of positive charges of metal M in the formula, the ligands include each X and multidentate ligand;

A is O, S, Se, $\overset{\backslash NR^{22}}{|}$, $-NR^{23}R^{24}$, $-N(O)R^{25}R^{26}$, $\overset{\backslash PR^{27}}{|}$, $-PR^{28}R^{29}$, $-P(O)R^{30}R^{31}$, sulfonyl, sulfoxidyl, $-Se(O)R^{39}$;

B is a group containing nitrogen atom, a group containing phosphor atom or hydrocarbyl;

D is O, S, Se, a group containing nitrogen atom, a group containing phosphor atom, a group containing selenium atom, sulfonyl and sulfoxidyl;

E refers to the group containing nitrogen atom, the group containing oxygen atom, the group containing sulfur atom, the group containing selenium atom, the group containing phosphor atom wherein the N, O, S, Se and P are coordination atoms;

G refers to an inert group, examples of the said inert group include hydrocarbyl, substituted hydrocarbyl and inert functional group;

B, E, G could link to one another;

• A " hydrocarbyl " is a univalent group containing only carbon and hydrogen, including alkyl group, cycloalkyl group, alkenyl group, alkynyl group, aromatic group, condensed rings group, heterocyclic group. If not otherwise stated, it is preferred that hydocarbyl group herein containing 1 to about 30 carbon atoms;

• A "substituted hydrocarbyl" refers to a hydrocarbyl which contains one or more substituent groups which are inert under the process conditions to which the compound containing these groups is subjected. The substituent groups also do not substantially interfere with the process. In another word, these substituent groups do not coordinate with metal. If not otherwise stated, it is preferred that hydocarbyl group herein contain 1 to about 30 carbon atoms. Included in the meaning of "substituted hydrocarbyl" are aromatic group, heteroaromatic rings, condensed rings group, heterocyclic group;

• A " inert functional group" herein refers to a group other than hydrocarbyl or substituted hydrocarbyl which is inert under the process conditions to with the compound containing the group is subjected. The functional groups also do not substantially interfere with any process described herein that the compound in which they are present may take part in. The functional group herein include a group containing oxygen atom, a group containing nitrogen atom, a group containing silica atom, a group containing germanium atom, a group containing sulfur atom or group containing stannum atom. Examples of functional groups include halogen (fluorine, chlorine, bromine and iodine), ether (-OR^{34} or TOR^{34}), ester of C_1-C_{10}, amine of C_1-C_{10}, alkoxyl of C_1-C_{10}, nitryl group. In case in which the functional group may be near an metal atom, the functional group should not coordinate to the metal atom more strongly than the group A, D, E, F, Y, Z which containing coordination atom and are shown as coordinating to metal atom, that is they should not displace the desired coordinating group;

• A "halogen" herein is fluorine, chlorine, bromine and iodine;

• A "group containing nitrogen atom" herein is $\overset{NR^{22}}{|}$, $—NR^{23}R^{24}$, $—T—NR^{23}R^{24}$ $—N(O)R^{25}R^{26}$, or $—T—N(O)R^{25}R^{26}$;

T is hydrocarbyl, substituted hydrocarbyl and inert functional group. If not otherwise stated, it is preferred that group herein contain 1 to about 30 carbon atoms;

• A "group containing phosphor atom" herein is $\overset{PR^{27}}{|}$, $PR^{28}R^{29}$, $—P(O)R^{30}R^{31}$, $-P(O)R^{32}(OR^{33})$, $-T-PR^{28}R^{29}$、$—T-P(O)R^{30}R^{31}$ or $-T-P(O)R^{32}(OR^{33})$;

• A "ether" herein is $-OR^{34}$ or $—TOR^{34}$;

•A "group containing oxygen atom" herein is hydroxyl, alkoxy (-OR^{34}), group with such as $–T-OR^{34}$;

• A "group containing sulfur atom" herein is $-SR^{35}$, $-T-SR^{35}$, $-S(O)R^{36}$, $-T-SO_2R^{37}$;

• A "group containing selenium atom" herein is $-SeR^{38}$, $-T-SeR^{38}$, $-T-Se(O)R^{39}$, $-Se(O)R^{39}$;

• A "group containing boron atom" herein is BF_4^-, $(C_6F_5)_4B^-$, $(R^{40}BAr_3)^-$ etc.;

•A "group containing aluminum atom" herein is alkyl aluminum compound, $AlPh_4^-$, AlF_4^-, $AlCl_4^-$, $AlBr_4^-$, AlI_4^-, $R^{41}AlAr_3^-$;

• A "group containing silicon atom" herein is $-SiR^{42}R^{43}R^{44}$, $-T-SiR^{45}$;

• A "group containing germanium atom" herein is $-GeR^{46}R^{47}R^{48}$, $-T-GeR^{49}$;

• A "group containing stannum atom" herein is $-SnR^{50}R^{51}R^{52}$, $-T-SnR^{53}$, $-T-Sn(O)R^{54}$;

• A "alkyl aluminum compound" herein is a compound in which at least one alkyl group is bound to aluminum atom, and halogen can also be bound to aluminum atoms in

the compound. Examples of alkyl aluminum compound include methyl aluminoxane(MAO), modified methyl aluminoxane (MMAO), $AlEt_3$, $AlMe_3$, $Al(i\text{-}Bu)_3$;

• R^1, R^2, R^3, R^{22}, R^{23}, R^{24}, R^{25}, R^{26}, R^{27}, R^{28}, R^{29}, R^{30}, R^{31}, R^{32}, R^{33}, R^{34}, R^{35}, R^{36}, R^{37}, R^{38}, R^{39}, R^{40}, R^{41}, R^{42}, R^{43}, R^{44}, R^{45}, R^{46}, R^{47}, R^{48}, R^{49}, R^{50}, R^{51}, R^{52}, R^{53}, R^{54} are each independently hydrogen, halogen (F, Cl, Br, I), hydrocarbyl, substituted hydrocarbyl or inert functional group. Each group above may be the same or not, and that any two of them which are vicinal may be linked to one another or to form a ring;

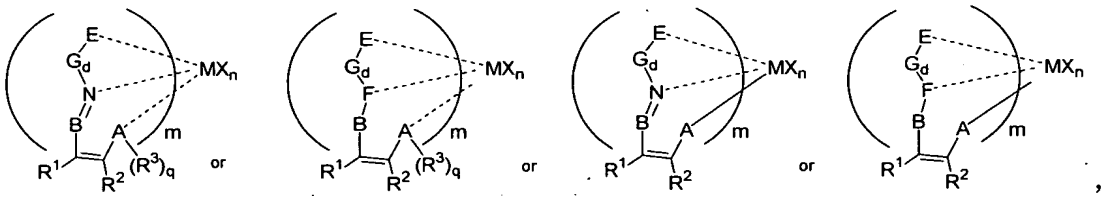
• A "catalytic system" herein is the system formed by catalyst mentioned above, or catalyst combined with cocatalyst W, or the catalyst supported on the carrier, or catalyst together with cocatalyst W supported on the carrier, or polymeric catalyst or polymeric catalyst combined with cocatalyst W;

• A "carrier" herein is polymer materials, silica, alumina, magnesium chloride titanium dioxide or the mixtures of two or more materials mentioned above.

• A "cocatalyst" herein is (a) a kind of neutral Lewis acid which could abstract X^- from the metal to form $(WX)^-$, and which is also capable of transferring an alkyl group or a hydride group to M, provided that $(WX)^-$ is a weakly coordinating anion. Examples of this kind of neutral Lewis acid include MAO and MMAO; or (b) a combination of following two kind of compounds, one kind compound is capable of transferring an alkyl or hydride group to metal and the other kind of compound is capable of abstracting X^- from the metal and form weakly coordinating anion. Examples of the former kind of compound include alkyl aluminum compound such as $AlEt_3$, $AlMe_3$, $Al(i\text{-}Bu)_3$ and the examples of the latter kind of compound include cationic Lewis acid ($Na[B(3,5\text{-}(CF_3)_2C_6H_3)_4]$ or $Ag[B(3,5\text{-}(CF_3)_2C_6H_3)_4]$, $NaOSO_2CF_3$ or $AgOSO_2CF_3$), alkyl aluminum compound or borane ($B(C_6F_5)_3$ etc.);

A " weakly coordinating anion " herein is the anion whose coordinating ability is known and has been discussed in the literature, see for instance W. Beck, et al., Chem. Rev., vol. 88, p. 1405-1421 (1988), and S. H. Strauss, Chem. Rev., vol. 93, p. 927-942 (1993), both of which are hereby included by reference. Among such anions are those formed from the aluminum compounds in the immediately preceding paragraph and X^-, including $(R^{41})_3AlX^-$, $(R^{41})_2AlX_2^-$, $(R^{41})AlX_3^-$, "$R^{41}AlOX^-$" . Other useful weakly coordinating anions include *p*-toluenesulfonate, SbF_6^-, PF_6^-, BF_4^-, $(C_6F_5)_4B^-$, $(R_fSO_2)_2N^-$, $CF_3SO_3^-$ or $((3,5\text{-}(CF_3)_2)C_6H_3)_4B^-$.

2. A catalyst or catalytic system for olefin polymerization and copolymerization as recited in claim **1**, the catalyst has the following formula:



wherein:

·····: refers to coordination bond or covalent bond;

—: refers to covalent bond or ionic bond;

Which, E binds M by coordination bond, A binds M by covalent bond and D binds M by coordination bond or by covalent bond;

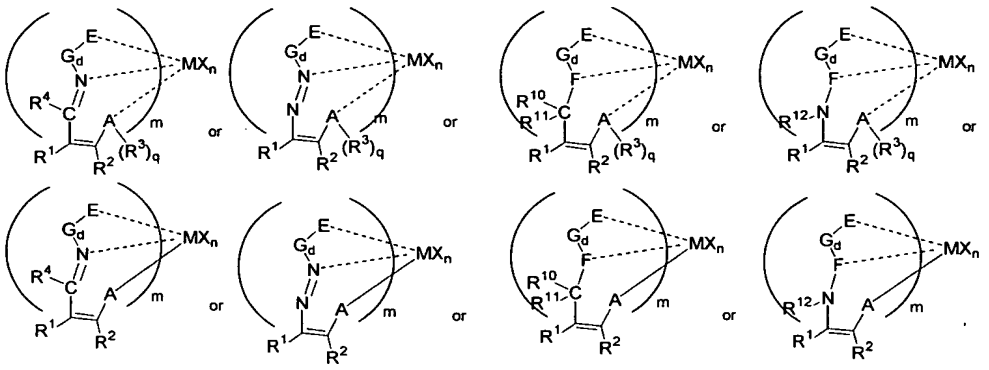
The descriptions of "A" , "B" , "E " , "G" , "d" , "q" , "m" , "M" ,

"n" , "X" , "R^1" , "R^2" and "R^3" are each independently as same as those recited in claim **1**;

F is group containing oxygen atom, group containing nitrogen atom, group containing sulfur atom, group containing phosphor atom or group containing selenium atom, and among which the coordination atom is N, O, S, Se, P;

The descriptions of "catalytic system" , "group containing oxygen atom" , "group containing nitrogen atom" , "group containing sulfur atom" , "group containing phosphor atom" and "group containing selenium atom" are each independently as same as those recited in claim **1**.

3. A catalyst or catalytic system for olefin polymerization and copolymerization as recited in claim **2**, the catalyst has the following formula:



wherein:

·····: refers to coordination bond or covalent bond;

—: refers to covalent bond or ionic bond;

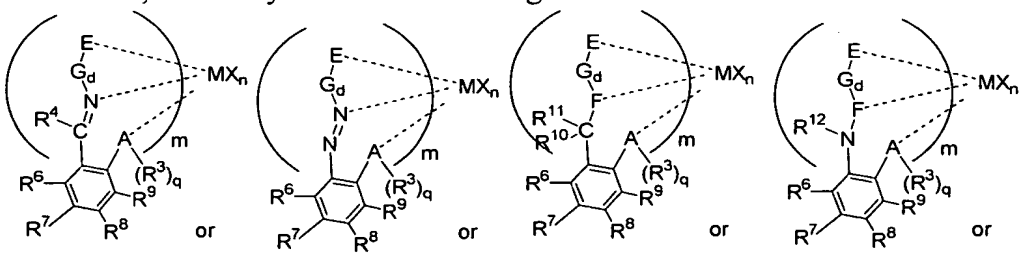
Which, E binds M by coordination bond, A binds M by covalent bond and D binds M by coordination bond or by covalent bond;

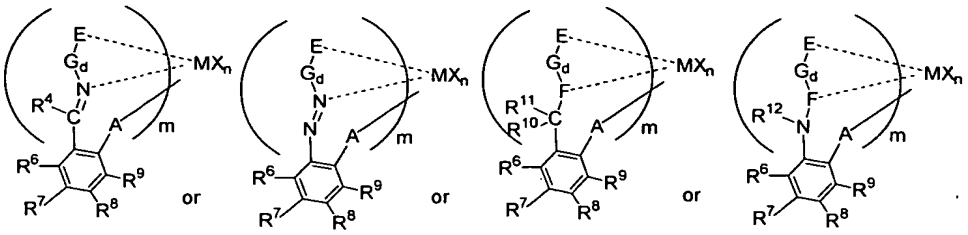
R^4, R^{10}, R^{11}, R^{12} are each independently hydrogen, halogen, hydrocarbyl, substituted hydrocarbyl, or inert functional group, each said group may be same or different, and any two of the groups vicinal to one another may link to each other or form a ring;

The descriptions of "A" , "E" , "F" , "G" , "d" , "q" , "m" , "M" , "n" , "X" , "R^1" , "R^2" and "R^3" are each independently as same as those recited in claim **2**;

The descriptions of "catalytic system" , "hydrocarbyl" , "substituted hydrocarbyl" and "inert functional group" are each independently as same as those recited in claim **1**.

4. A catalyst or catalytic system for olefin polymerization and copolymerization as recited in claim **3**, the catalyst has the following formula:





wherein:

·····: refers to coordination bond or covalent bond ;

—: refers to covalent bond or ionic bond;

Which, E binds M by coordination bond, A binds M by covalent bond and D binds M by coordination bond or by covalent bond;

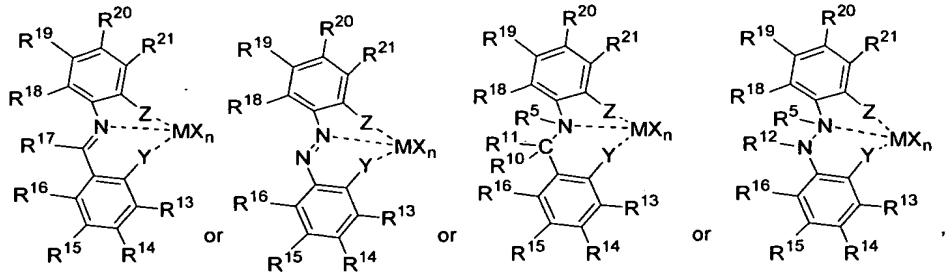
R^6, R^7, R^8, R^9: are each independently hydrogen, halogen, hydrocarbyl, substituted hydrocarbyl, or an inert functional group;

The descriptions of "A" , "E" , "F" , "G" , "d" , "q" , "m" , "M" , "n" , "X" , "R^3" , "R^4" , "R^{10}" , "R^{11}" and "R^{12}" are each independently as same as those recited in claim **3**;

R^3, R^4, R^6, R^7, R^8, R^9, R^{10}, R^{11}, R^{12} may be same or different, and any two of the groups vicinal to one another may link to each other or form a ring;

The descriptions of "catalytic system" , "hydrocarbyl" and "substituted hydrocarbyl" are each independently as same as those recited in claim **1**.

5. A catalyst or catalytic system for olefin polymerization and copolymerization as recited in claim **4**, the catalyst hasthe following formula:



wherein:

·····: refers to coordination bond or covalent bond;

—: refers to covalent bond or ionic bond;

Which, E binds M by coordination bond, A binds M by covalent bond and D binds M by coordination bond or by covalent bond;

R^{10}, R^{11}, R^{12}, R^{13}, R^{14}, R^{15}, R^{16}, R^{17}, R^{18}, R^{19}, R^{20}, R^{21} are each independently hydrogen, halogen, hydrocarbyl, substituted hydrocarbyl, or an inert functional group. Each said group may be same or different, and any two of the groups vicinal to one another may link to each other or form a ring;

R^5 is the lone pair electron of nitrogen atom, H, hydrocarbyl, substituted hydrocarbyl, group containing oxygen atom, group containing sulfur atom, group containing nitrogen atom, group containing phosphor atom. When R^5 is one of the groups containing oxygen atom or sulfur atom or nitrogen atom or selenium atom or phosphor atom, the N or O or S or P or Se atom in the group may coordinate with metal (M);

Y and Z are each independently group containing oxygen atom, group containing nitrogen atom, group containing sulfur atom, group containing phosphor atom or group

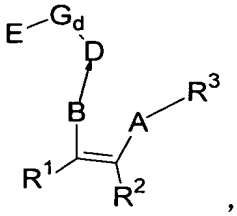
containing selenium atom;

The descriptions of "T", "M", "X", "n", "catalytic system", "hydrocarbyl", "substituted hydrocarbyl", "group containing oxygen atom", "group containing nitrogen atom", "group containing sulfur atom", "group containing phosphor atom" and "group containing selenium atom" are each independently as same as those recited in claim **1**.

6. A catalyst or catalytic system for olefin polymerization and copolymerization as recited in claim **1, 2, 3, 4** or **5,** wherein the M is the 4^{th} group metal in the highest oxidative station.

7. The synthesis procedure of catalyst used for the olefin polymerization and copolymerization as recited in claim **1** wherein the catalyst is prepared in organic solvent by mixing the ligand or the anion of the ligand with transition metal complex MX_g in mole ration 1:0.1~6 for 0.5~40 hours under the –78°C to reflux temperature;

The ligand has the following formula:



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wherein the descriptions of "d", "A", "B", "D", "E", "G", "→", "—", "R^1", "R^2" and "R^3" are each independently as same as those recited in claim **1**; in the transition metal complex MX_g, g is 1, 2, 3, 4, 5 or 6; the descriptions of M and X are each independently as same as those recited in claim **1**.

8. The usage of catalyst or catalytic system used for the olefin polymerization and copolymerization as recited in claim **1** wherein the catalyst or catalytic system with/without cocatalyst could catalyze olefin oligomerization, polymerization and copolymerization as homogeneous catalyst or heterogeneous catalyst; The said homogeneous catalyst is meant the catalyst or the catalytic system used directly without supported on the carrier; The said heterogeneous catalyst is meant the catalyst or the catalytic system used after supported on the carrier such as polymer materials, silica, alumina, magnesium chloride etc. or the mixtures of the said carrier; The said olefin is meant ethylene, α-olefin, styrene, alkenoic acid and its derivatives, alkenols and its derivatives, diene, cycloalkene, norbornene and its derivatives and other alkene with functional group; The said α-olefin is meant an alkene containing 1 to 30 carbon such as propylene, 1-butene, 1-pentene, 1-hexene, 1-octene, 4-methyl-1-pentene and mixtures of them; The said cycloalkene is meant cyclopentene, cyclohexene, norbornene and its derivatives; The said alkene with functional group is meant an alkene containing one or more inert functional group, such as vinyl acetate, phenylacetylene, acrylonitrile, acrylamide, alkenyl ether and alkenyl ester.

9. The usage of catalyst or catalytic system used for the olefin polymerization and copolymerization as recited in claim **8** wherein the said copolymerization is meant the copolymerization of ethylene with α-olefin, the copolymerization of the ethylene with alkene with functional group, the copolymerization of α-olefin with alkene containing

functional group and the copolymerization between the α-olefins; The descriptions of the said "olefin", "alkene with functional group" and "α-olefin" are independently as same as those recited in claim **8**.

10. The usage of catalyst or catalytic system used for the olefin polymerization and copolymerization as recited in claim **8** wherein the said carrier is meant polymer materials, silica, alumina, magnesium chloride etc. or the mixtures of the said supports.

11. The usage of catalyst or catalytic system used for the olefin polymerization and copolymerization as recited in claim **8** wherein the said the catalyst or catalytic system could be used as homogeneous or heterogenous catalyst (or catalytic system) to (co)polymerization olefin under the following conditions: polymerization pressure is 0.1~10Mpa, polymerization temperature is -50~150℃, the mole ratio of catalyst *vs* cocatalyst is 1:1~5000. The descriptions of "catalyst", "catalytic system" and "cocatalyst" are each independently as same as those recited in claim **1.** The description of "olefin" is as same as those recited in claim **8**.